ENERGY ENGINEERING ANALYSIS PROGRAM

FORT CAMPBELL, KENTUCKY

ENERGY AUDIT OF DINING FACILITIES

FINAL REPORT

AUGUST, 1986

EXECUTIVE SUMMARY

Prepared for

LOUISVILLE DISTRICT, CORPS OF ENGINEERS

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ARMY CONTRACT NO. DACA27-85-C-0171

DEPARTMENT OF THE ARMY
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INDEX OF VOLUMES

EXECUTIVE SUMMARY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

INTRODUCTION

This volume is a summary of the results of the final report of the Energy Engineering Analysis Program (EEAP) Study of 30 selected dining facilities at Fort Campbell, Kentucky. BENATECH was contracted by the Louisville District, U.S. Army Corps of Engineers, Louisville, Kentucky under Contract No. DACA27-85-C0171. This EEAP study identifies cost-effective energy conservation opportunities (ECOs) and prepares appropriate programming documentation for these ECOs. The facilities included in the contract are listed in Table ES.1. All of the buildings are permanent structures with the exception of Bldg 2740.

The following activities have been accomplished:

- A detailed field investigation has been conducted.
- ECO calculations have been performed and ECIP analyses completed.
- Interim Report has been submitted.
- Project documentation packages compiled.
- Executive Summary and Narrative have been incorporated into the report.

Each item of the Contract Scope of Work has been addressed during the development of the study. The results of accomplishments are presented in the narrative report and in the reference volumes as required.

OVERVIEW OF TECHNICAL APPROACH

The following tree (page 3) represents the sequence of events that were used in the development of this project. This analysis tree depicts the steps taken to accomplish the specified work requirements. Detailed discussions for each of these steps will be presented in the report.

TABLE ES.1 List of Buildings Identified in the Scope of Work.

CATEGORY	BUILDING NO.
Recent Construction	3717,3721,4061
Airfield	7122
Clarksville Base	7523
Korean Barracks	3211,3216,6709,6725 6728,6910,6730,6733 6775,6776,6779,6911 6782,6927,6930,6937 6939,6917,6942,6944 6919,6923
Old Hospital	154
Stockade	6801
World War II Temporary	2740

- Field Survey
  - Data Reduction
    - Building Energy Analysis Program Analyses
    - Initial ECO Analyses
      - ECOs deemed not feasible for dining facilities
      - ECOs warranting further study
        - ECOs not meeting acceptance criteria
        - ECOs meeting acceptance criteria
          - Prepare programming documentation
            - Submit report

The ECO analyses were developed on computer templates which were modified to meet changing requirements and conditions. The templates were set up using ASHRAE, MEANS, and other sources where referenced. A prime engineer was responsible for developing a particular ECO. A check engineer was assigned to verify all assumptions and calculations. The project manager reviewed each ECO to verify that it met the Scope of Work requirements.

COMPUTER SIMULATION

A computerized building energy simulation program is used to estimate current energy usage in the facilities since no individual metering exists for the dining facilities. The only metering available is basewide.

The specific program utilized is the Building Energy Analysis Program developed by Elite Software Development, Inc. (ESD). ESD is based on ASHRAE

(American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.) standards. For purposes of this report, the ESD program is used to derive energy use figures for each type of dining facility through simulation runs.

Computer simulation of building energy usage has been available for over ten years, with considerable advancement in the past five years. The user has the ability to estimate building energy usage by modeling the building construction, occupancy, equipment, and systems with the use of a computer. Weather conditions are simulated by the program given input data from the National Oceanic and Atmospheric Administration (NOAA) for the local climate. Simulation programs range from relatively simple programs that can be inputted and run on a microcomputer to more sophisticated programs that require a mainframe computer. ESD can be run entirely on a microcomputer.

The computer simulation is first run to show the present conditions energy usage. The ESD "present condition" simulations were then modified to reflect incorporation of ECOs with SIR > 1.00 (Appendix E1).

PRESENT CONDITIONS

The dining facilities' present conditions were established by:

- Conducting a field survey of all buildings
- Obtaining and verifying building drawings.
- Obtaining and verifying utility rate and billings.
- Reviewing government documentation

The thirty dining facilities are divided into nine typical categories and computer simulated for energy consumption. The categories included the Korean Barracks, the World War II Temporary, the three free standing dining facilities, the stockade, the old hospital, the airfield dining room, and the Clarksville barracks. Each of the categories have different HVAC systems, electrical systems, building envelopes, schedules of operation and equipment, number of people working and served, domestic hot water usage, and lighting.

These computer simulations are the basis for developing the fiscal year 1986 baseline energy consumption. Based on the simulations, the present total consumption of energy for the thirty dining facilities is 118,657 MBTUs per year (75,036 MBTU/Yr of electricity and 43,621 MBTU/Yr of natural gas).

UTILITY RATES

Fort Campbell's dining facilities use several types of energy. Electricity is provided by Tennessee Valley Authority (TVA). Natural gas is purchased from the Clarksville Gas Company. The fuel oil is received by several different suppliers. The fuel oil is primarily used as a backup for the natural gas in their central steam system.

ENERGY CONSERVATION OPPORTUNITIES (ECOs) CONSIDERED

Wall Insulation. This ECO analyzes the potential for installing additional wall insulation for increasing the R-value of the wall, thus reducing the energy transmission through the wall.

Roof Insulation. This ECO analyzes the potential for installing additional roof insulation for increasing the R-value of the roof, thus reducing the energy transmission through the roof.

Double Pane Windows. This ECO analyzes the potential for installing additional glazing thereby reducing the energy transmission through the window.

Weatherstripping and Caulking. This ECO looks at adding weatherstripping and/or caulking around doors and windows to reduce the loss of conditioned air.

Solar Film. This ECO analyzes the potential for adding solar film to lower the shading coefficient thereby reducing the solar transmission.

Vestibule Installation. This ECO investigates the possibility of installing an vestibule on the entrance to reduce infiltration and thus reduce the loss of conditioned air.

Air Curtain Installation. This ECO investigates the possibility of installing an air curtain to reduce the loss of conditioned air.

U-Tube Replacement. This ECO analyzes the possibility of replacing the existing lamps with energy efficient lamps to save on electrical energy used.

Lighting Reduction Analysis. This ECO analyzes the possibility of removing some of the existing lamps to reduce the footcandles to Army regulations and save electrical energy.

Fluorescent Conversion Analysis. This ECO analyzes the potential of converting the incandescent lighting in the dining facilities to lower wattage fluorescent lighting.

Exit Light Conversion. This ECO analyzes the potential of converting the incandescent lamps in the EXIT light fixtures to lower wattage fluorescent lamps.

Night Setback. This ECO looks at the possible energy savings that can be achieved by setting back the thermostat after occupied hours during the heating season.

Dry Bulb Economizer. This ECO analyzes the potential for installing a dry bulb economizer that utilizes energy savings by allowing outside air to circulate through the building and turning off the compressor.

Heat Reclaim from Kitchen Exhaust. This ECO determines the feasibility of using a run-around heat recovery loop to recover energy from kitchen exhaust fans in order to preheat makeup air and thus save heating energy.

Pipe Insulation. This ECO analyzes the energy savings potential of installing additional insulation to the piping system, thus saving on distribution losses.

Heat Recovery from Dishwater. This ECO studies the benefits of installing a heat recovery system utilizing the dishwasher waste water to preheat domestic hot water.

Make-Up Air to Kitchen Hoods. This ECO asses energy and cost savings that can be achieved by installing a new kitchen hood with makeup air.

Refrigeration Waste Heat Recovery. This ECO asses the feasibility of recovering waste heat from refrigeration equipment to preheat domestic hot water.

Destratification/Ceiling Fans. This ECO analyzes the potential energy savings that can be achieved by installing ceiling fans to destratify the air in dining areas.

DHW Controls Modification. This ECO asses the feasibility of modifying the domestic hot water controls to cut off steam supplied to the converter during unoccupied hours.

DHW Tank Insulation. This ECO analyzes the energy savings potential of installing additional insulation to the domestic hot water tank, thus saving on standby losses.

Lower DHW Temp/Add Booster Heater. This ECO studies the benefits of replacing the existing domestic hot water heating equipment with an instantaneous hot water heater, thus eliminating standby losses.

Reduce DHW Temp. This ECO asses the feasibility of reducing the present domestic hot water temperature to save energy and dollars.

Heat Pump Water Heater. This ECO analyzes the potential of using heat pumps for domestic water heating in the dining facilities.

CONCLUSIONS

BENATECH concludes that there are several opportunities to save energy in the dining facilities at Fort Campbell, Kentucky.

The ECOs that meet the Army requirement of savings to investment ratio (SIR) of greater than or equal to one are incorporated into the computer

simulation to determine the potential energy reductions. The simulations take into account the interdependence of the individual ECOs. A summary of the computer simulations is used to establish the fiscal year 1990 projected energy comsumption.

The effects of the proposed ECOs on the facilities energy consumption can be seen in the simulation output (refer to Appendix E2). Table ES.2 summarizes the energy consumption figures for the existing conditions.

Tables ES.3 and ES.4 list the energy savings realized after implementation of the proposed "Dining Facilities Improvements" ECIP project and the ten low cost/no cost projects.

Under the Scope of Work, BENATECH performed an energy efficient motors survey at Fort Campbell. Of the 527 motors surveyed, 144 were recommended for replacement with premium efficiency motors. This study was completed as an addendum to the Energy Savings Opportunity Survey (ESOS) of April 1985; the motors survey has been submitted as a supplemental report to the ESOS study.

RECOMMENDATIONS

Packaging of the proposed ECOs was determined by the installation based on recommendations made by BENATECH, INC. and FORSCOM. The proposed energy conservation opportunities are packaged into two groups: an ECIP project and ten Low/No Cost projects. The ECIP project, titled "Dining Facilities Improvements", will save 6,748 MBTUs/yr in natural gas and 3,632 MBTUs/yr in electrical energy consumption. Implementation of this ECIP project will save $44,362 per year.

The Low/No Cost projects will decrease the energy consumption by 715 MBTUs/yr in natural gas and 1575 MBTUs/yr in electricity. The annual savings in energy costs amounts to $8,502.

The Energy Efficient Motors ECO is packaged as an ECIP project and submitted as a supplement to the Fort Campbell ESOS study of 1985. The replacement of 144 motors with premium efficiency motors reduces annual electrical usage by 11,874 MBTUs and saves $44,823 per year.

The project's energy savings and cost savings are depicted in graphs GES.1 and GES.2.

Fort Campbell Dining Facilities - EEAP
Summary of Building Energy Analysis Computer Simulation

TABLE ES.2 ENERGY CONSUMPTION SUMMARY FOR EXISTING CONDITIONS

Bldg #	Floor Area (sqft)	Total Usage (KBtu)	Energy Use Per Unit Area (KBtu/sqft)	Peak Energy Usage (month, KBtu)	
154	12,540	4,574,259	365	JAN	634,760
2740	3,071	3,883,029	1264	JAN	485,613
3717	15,676	8,508,811	543	JAN	1,139,413
3721	5,423	4,996,126	921	JAN	634,937
4061	14,046	13,087,235	932	JAN	1,679,048
6801	5,504	2,618,425	476	JAN	345,407
22 Korean Barracks	103,620	72,935,016	704	JAN	7,452,786
7122	5,888	4,149,933	705	JAN	577,180
7523	11,385	3,903,854	343	JAN	432,941

TABLE ES.3
DINING FACILITIES IMPROVEMENT ECIP PROJECT

ECO TITLE & BUILDING NO.	ENERGY SAVINGS (MBtu/yr) FUEL	ELEC.	ANNUAL $ SAVINGS	COST ($)	SIR	PAYBACK (years)
ROOF INSULATION						
7122	65.3	33.6	$325	$3,457	1.66	10.6
6801	335.0	--	$1,267	$12,087	2.07	9.5
6942	51.0	52.8	$316	$2,494	2.07	7.9
6709	51.0	52.8	$316	$2,494	2.07	7.9
TOTAL	502.3	139.2	$2,224	$20,532	--	9.2
HEAT RECOVERY FROM DISHWATER						
6725	240.2	--	$903	$4,375	4.11	4.8
TOTAL for 26 Mess Halls	6245.2	--	$23,478	$113,750	4.11	4.8
FLUORESCENT CONVERSION ANALYSIS						
154	--	128.0	$620	$2,977	2.35	4.8
3211	--	62.0	$366	$1,555	2.66	4.2
7122	--	65.0	$381	$1,625	2.66	4.3
6801	--	40.0	$233	$991	2.67	4.3
3216	--	106.0	$606	$2,474	2.78	4.1
3717	--	18.0	$105	$424	2.79	4.0
6779	--	83.0	$475	$1,909	2.82	4.0
6927	--	67.0	$380	$1,519	2.84	4.0
6942	--	131.0	$731	$2,827	2.93	3.9
4061	--	613.0	$3,424	$13,286	2.93	3.9
6910	--	123.0	$660	$2,297	3.25	3.5
6944	--	121.0	$772	$2,646	3.32	3.4
6930	--	122.0	$775	$2,651	3.33	3.4
6725	--	102.0	$654	$2,082	3.57	3.2
6782	--	87.0	$572	$1,796	3.63	3.1
6730	--	86.0	$564	$1,761	3.65	3.1
6937	--	104.0	$650	$1,973	3.75	3.0
6709	--	126.0	$588	$1,763	3.78	3.0
6923	--	82.0	$529	$1,560	3.86	2.9
6776	--	70.0	$473	$1,373	3.92	2.9
6911	--	54.0	$270	$779	3.92	2.9
3721	--	25.0	$122	$355	3.93	2.9
6917	--	81.0	$525	$1,515	3.95	2.9
6939	--	70.0	$347	$955	4.10	2.8
6919	--	71.0	$347	$919	4.28	2.6
6775	--	323.0	$1,336	$3,248	4.63	2.4
6728	--	351.0	$1,483	$3,413	4.90	2.3
6733	--	92.0	$377	$811	5.26	2.2
TOTAL	--	3403.0	$18,365	$61,484	--	3.3
EXIT LIGHT CONVERSION						
3721	--	37.8	$125	$361	3.89	2.9
3717	--	31.5	$104	$301	3.92	2.9
6782	--	9.5	$31	$91	3.97	2.9
6779	--	10.7	$35	$91	4.37	2.6
TOTAL	--	89.5	$295	$844	--	2.9
ECIP PROJECT TOTAL	6747.5	3631.7	$44,362	$196,610	3.66	4.4

TABLE ES.4
LOW/NO COST PROJECTS

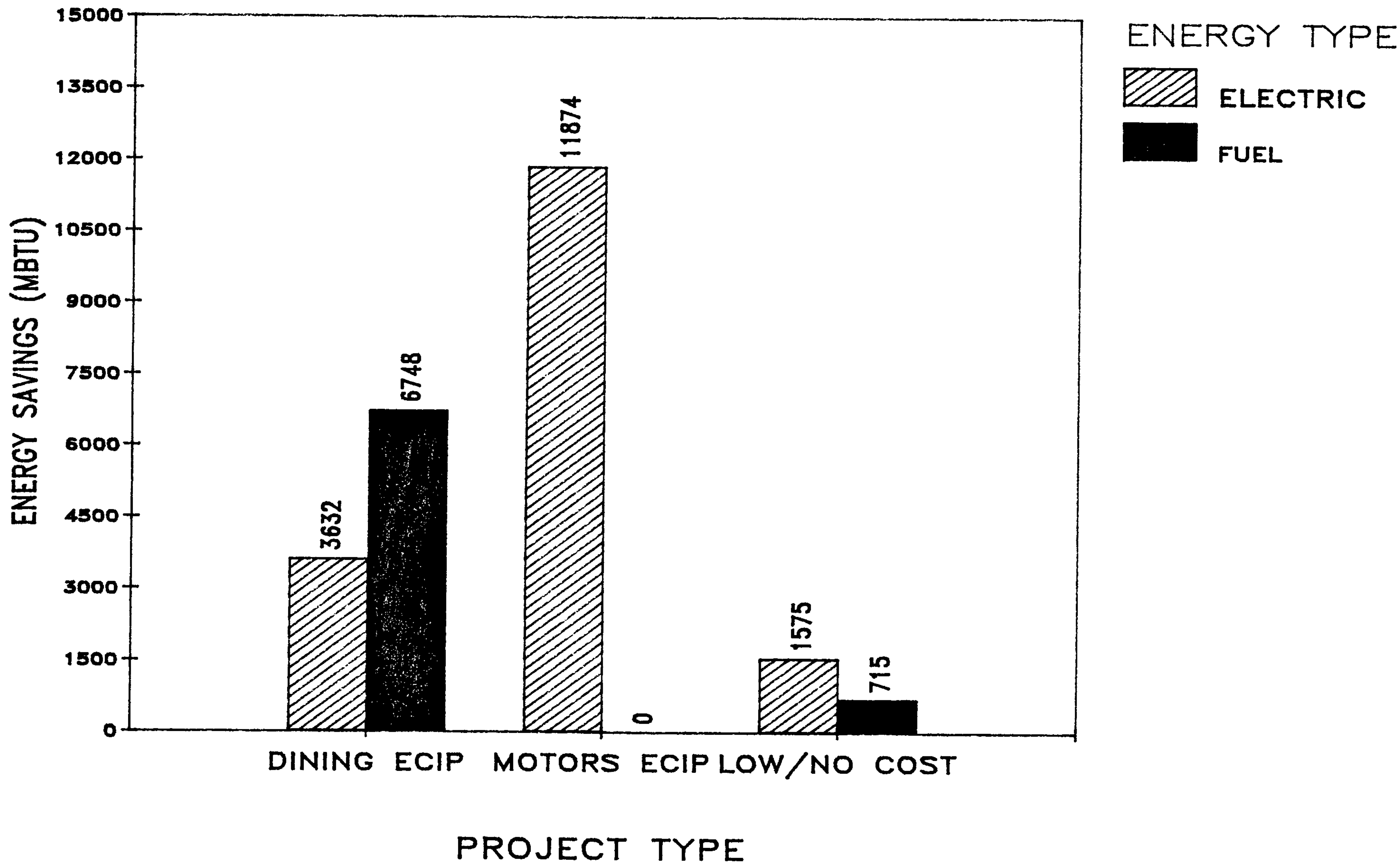
PROJECT		ENERGY SAVINGS (MBtu/yr) FUEL	ELEC.	ANNUAL $ SAVINGS	COST ($)	SIR
WEATHERSTRIPPING AND CAULKING						
	6923	4.3	0.8	$18	$117	2.93
	4061	2.9	0.6	$12	$85	2.70
	7122	8.0	1.5	$34	$275	2.32
	154	10.3	1.9	$43	$453	1.80
	2740	1.6	0.3	$7	$127	1.00
	TOTAL	27.1	5.1	$114	$1,057	2.04
LIGHT REDUCTION ANALYSIS		--	1212.0	$4,667	$916	57.27
NIGHT SETBACK						
	2740	42.0	7.0	$174	$124	17.73
HEAT RECLAIM FROM KITCHEN EXHAUST						
	4061	177.0	--	$666	$8,256	1.60
PIPE INSULATION						
	6937	10.6	--	$40	$29	27.45
	6911	21.8	--	$83	$75	21.95
	6930	41.5	--	$157	$191	16.26
	6917	16.7	--	$63	$100	12.72
	6927	25.2	--	$95	$160	11.80
	154	214.0	--	$810	$1,357	11.80
	3211	14.0	--	$53	$120	8.73
	3717	4.3	--	$16	$38	7.88
	2740	28.0	--	$106	$403	5.20
	6910	18.9	--	$72	$403	3.53
	6801	3.2	--	$12	$70	3.39
	6944	1.2	--	$4	$53	1.65
	TOTAL	399.4		$1,511	$2,999	9.97
DESTRATIFICATION / CEILING FANS						
	7122	1.5	73.8	$178	$278	5.53
	154	4.1	37.9	$103	$278	3.41
	3721	1.0	29.5	$73	$278	2.29
	3717	1.8	25.2	$66	$560	1.05
	TOTAL	8.3	166.4	$420	$1,394	2.66
DHW CONTROLS MODIFICATION						
	154	16.0	--	$30	$425	1.85
DHW TANK INSULATION						
	2740	21.6	--	$82	$246	6.69
REDUCE DHW TEMPERATURE						
	2740	38.2	--	$144	$11	259.58
	6942	5.9	--	$23	$11	40.47
	154	3.6	--	$14	$11	24.69
	6911	3.0	--	$11	$11	20.34
	TOTAL	50.7		$192	$44	86.22

TABLE ES.4
LOW/NO COST PROJECTS

PROJECT	ENERGY SAVINGS (MBtu/yr) FUEL	ELEC.	ANNUAL $ SAVINGS	COST ($)	SIR
ENERGY EFFICIENT LIGHTING RETROFIT					
U-TUBE REPLACEMENT					
3211	--	22.0	$55	$35	17.11
6725,6730,6775,6776,6917,6930	--	20.0	$49	$32	17.11
6782,6923	--	20.0	$50	$32	17.11
3216	--	23.0	$56	$37	16.88
6728,6937	--	19.0	$46	$31	16.46
6733,6779,6910,6927,6709	--	19.0	$47	$32	15.95
FLOURESCENT CONVERSION ANALYSIS					
2740	--	31.0	$183	$778	2.66
7523	--	25.0	$143	$563	2.87
EXIT LIGHT CONVERSION					
7523	--	5.2	$17	$32	5.82
TOTAL		184.2	$646	$1,572	4.59

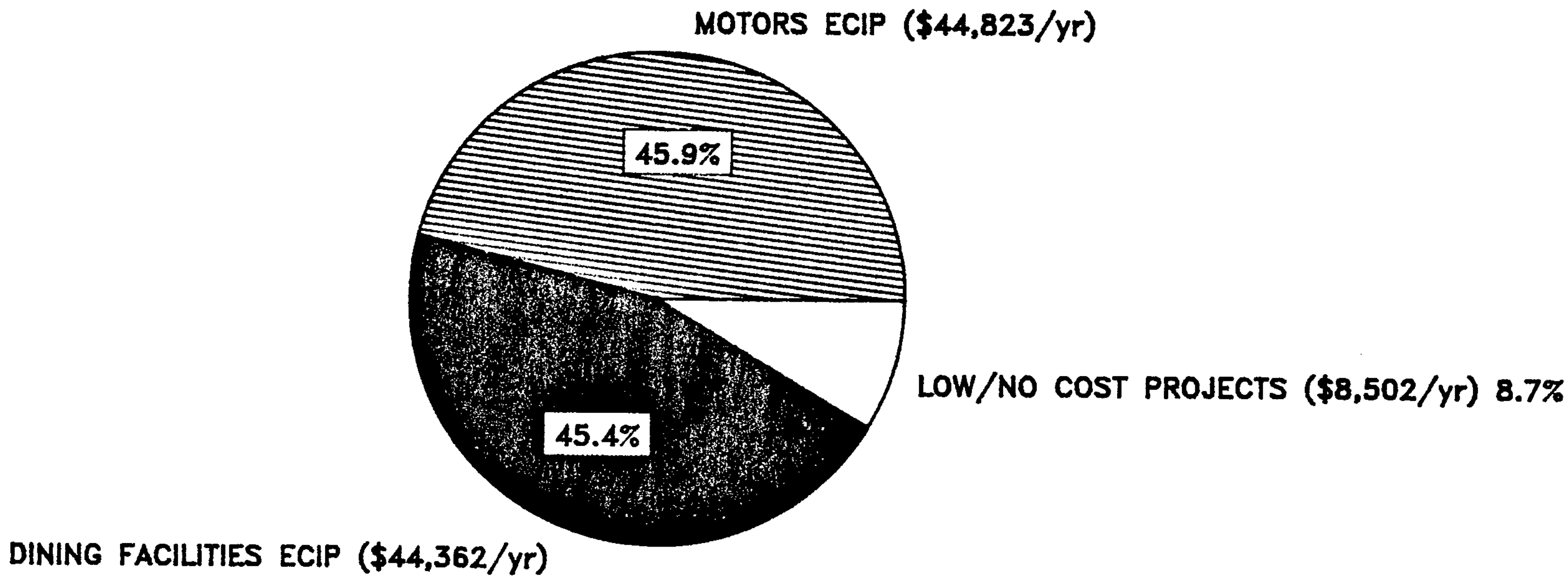
PROJECT ENERGY SAVINGS

Ft. Campbell Dining Facilities



GRAPH GES.1

PROJECT COST SAVINGS
Ft. Campbell Dining Facilities



GRAPH GES2